

# **The Cost- effectiveness of Mixes of Operational Approaches to Polio Eradication: Findings of Two Case Studies**

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for Health  
Reform



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# Abstract

This report examines the cost-effectiveness of variations of fixed site and house-to-house service delivery approaches to reach polio eradication through the analysis of two specific case studies. One country study was Cambodia, which evaluated and compared the costs and effectiveness of operational approaches involving different combinations of national immunization days (NIDs) and high-risk response immunizations (HRRIs) as well as different levels of surveillance. The second country case study, Turkey, examined whether house-to-house campaigns are more cost-effective with more intensified management. The results indicate that conducting NIDs and HRRIs is more cost-effective when an adequate surveillance system is in place, that combining the two approaches of NIDs and house-to-house immunizations into one activity allows cost savings to be realized, and that house-to-house immunization activities with greater investment in management support, while being costlier, are, on average, more cost-effective than those with limited management support.

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# Acronyms

<b>AFP</b>	Acute Flaccid Paralysis
<b>DPT</b>	Diphtheria, Pertussis, Tetanus
<b>FIC</b>	Fully Immunized Child
<b>HRRI</b>	High-Risk Response Immunization
<b>MECACAR</b>	Mediterranean, Caucasus, Central Asian Republics
<b>MOH</b>	Ministry of Health
<b>NID</b>	National Immunization Day
<b>OPV</b>	Oral Polio Vaccine
<b>PHR</b>	Partnerships for Health Reform Project
<b>REACH</b>	Resources for Child Health Project
<b>WHO</b>	World Health Organization



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# Executive Summary

This report presents two case studies, conducted in order to examine the cost-effectiveness of variations of fixed site and house-to-house service delivery approaches to reach polio eradication. The Cambodia case study evaluated and compared the costs and effectiveness of operational approaches involving different combinations of national immunization days (NIDs) and high-risk response immunizations (HRRIs) and also different levels of surveillance.

First, to assess the additional costs associated with immunizing hard-to-reach populations, the costs of the February/March 1997 NIDs and combined NID/HRRI of November/December 1997 are compared since the latter activity involved the use of additional resources such as mobile boat teams in order to reach children living along the Cambodia's waterways. To assess the cost-effectiveness associated with different quality surveillance systems, Cambodia's HRRI program conducted in February/March 1998, with good surveillance, is compared with the simulated costs of conducting a nationwide HRRI with poor surveillance. The third part of the Cambodia case study examines the cost-effectiveness of combining campaign approaches, as in the November/December 1997 NID/HRRI, as compared with the cost-effectiveness of two separate campaign activities, as in the February/March 1997 NID and May/June 1997 HRRI.

The results indicate that conducting NIDs and HRRIs were more cost-effective when an adequate surveillance system was in place and cost savings were realized since a non-targeted approach would have cost more than the targeted approach. Having reasonable surveillance allows countries to target when they conduct house-to-house activities. These results suggest that countries should make strong efforts to improve their AFP (acute flaccid paralysis) surveillance, because they will then be able to realize cost savings without lowering the effectiveness of their activities.

Combining the two approaches of NIDs and house-to-house immunization into one activity allowed cost savings to be realized for the combined activity since resources could be shared for the two activities. The cost per dose administered was about \$1.00 for the two separate activities and only about \$0.70 for the combined activities. In addition, the cost per case of paralytic polio was about 30 percent higher when the two activities were conducted separately. The combined approach is an approach that countries may want to consider when they have limited resources for campaigns but are still trying to reach the harder-to-reach groups. However, one disadvantage of taking this approach could be that additional planning and training would make this approach more complicated.

The aim of the Turkey case study was to examine whether house-to-house campaigns are more cost-effective with more intensified management, e.g., additional resources provided for supervision, social mobilization, and training. A house-to-house campaign (1998 NIDs) with limited management support was compared with a more intensive house-to-house campaign (1999 mop-ups) in provinces that had been identified as having low-immunization coverage. A second comparison was to compare approaches to nationwide campaign, that is, the 1998 NIDs that had limited management support were compared with the 1999 NIDs, which received more support, i.e. more training, supervision, and social mobilization. The results indicate that intensive house-to-house immunization activities, while more costly, were on average more cost-effective than those with limited management support as in the case of the NIDs in 1998 due to their increased effectiveness. This finding suggests that greater investment in management support for activities in provinces with low-coverage provides sufficient benefits to make it cost-effective even though the costs of the activity will increase. In addition, the

involvement of the central level in the mop-up campaigns increased the health worker motivation in the provinces for the polio eradication campaigns.

The 1999 NIDs were also compared with the 1998 NIDs since more investment in management of the activities took place in the former one. The findings also indicated that the later NIDs, with increased management support in both low- and high-coverage areas, were more cost-effective than the 1998 NIDs. Despite the fact that the NIDs were a less intensive activity than the mop-ups, additional funding for management support still increased the cost-effectiveness of the campaign in 1999.

The results indicated that well-managed house-to-house immunization activities, while being costlier, were on average more cost-effective than those with limited management support as in the case of the NIDs in 1998. The mop-ups were found to be more cost-effective because they were able to increase the coverage of children with their intensified approach. Another benefit was the higher health worker motivation in the provinces for conducting these activities. This finding suggests that greater investment in management support of activities provides sufficient benefits even though the costs of the activity will increase.

A similar finding for between different NIDS programs was found since the 1999 NID, which had greater management support, was found to be more cost-effective than the 1998 NID. This result suggests that even without high central-level involvement as in the case of the mop-up campaigns, additional funding for management support increased the cost-effectiveness of the campaign.

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# 1. Introduction

The Global Polio Eradication Initiative was launched during a World Health Assembly meeting in 1988 and began accelerated polio eradication activities in 1994/95. Since it began, the campaign has made substantial progress. With a reduction in cases of polio reported from 350,000 (1988) to 6,500 (1999), the global goal of eradication is in sight. The region of the Americas has been certified polio free and the Western Pacific region is anticipating certification in 2000. However, despite these accomplishments, pockets of wild poliovirus are still present in the Asian and African regions. In order to achieve global eradication, the World Health Organization (WHO) and other partners such as United States Agency for International Development (USAID) are advocating for an acceleration of polio eradication activities in the year 2000. However, shortfalls in funding are present and information on how to conduct more cost-effective polio eradication campaigns is critical at this juncture.

To address these concerns, the Partnerships for Health Reform (PHR) conducted two case studies on the cost-effectiveness of the mix of operational approaches that were taken in two countries. The two case studies include: 1) Cambodia, whose program increased the effectiveness of its campaigns through the use of mobile teams along the waterways, and 2) Turkey, whose program increased its effectiveness through increasing the management support for its polio eradication activities. The purpose of this study is to illustrate that cost considerations can be beneficial to the eradication effort and cost savings can be realized without lowering effectiveness.



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## 2. Background

Four main operational approaches have been used in the polio eradication initiative. The first is to achieve and maintain high routine immunization coverage with three doses of oral polio vaccine (OPV) provided to the target population. This strategy targets children under the age of one. A second approach supplements routine immunization activities through National Immunization Days (NIDs) in endemic countries. Several regional initiatives have taken place that coordinate supplementary activities across national borders. The third approach is known as mopping-up activities, conducted in countries in the final phase of eradication and with the goal of eliminating the remaining reservoirs of wild poliovirus. During these campaigns, OPV is delivered house-to-house to all targeted children within a specified geographic area.

Lastly, to increase the effectiveness of polio eradication immunization activities and monitor their progress, surveillance systems of acute flaccid paralysis (AFP)<sup>1</sup> have been put into place. AFP surveillance requires detection, investigation and reporting of AFP in children under the age of 15 years old. The two main indicators of AFP surveillance to measure the quality of AFP surveillance and guide polio eradication activities are: 1) the rate of reporting AFP cases not due to polio, or the non-polio AFP rate<sup>2</sup>, and 2) the percentage of AFP cases that have two stool samples taken within 14 days of onset of paralysis.

Most countries have used a mixture of these operational approaches in their campaigns to eradicate polio, and the mixture has depended on the particular needs and resources of the country. Some of the important decisions have been when and how to conduct house-to-house campaigns, activities that are costly but often necessary to reach all children under five in an eradication campaign. The timing will depend on such parameters as level of surveillance and management capacity of program managers. The next two sub-sections describe the polio eradication programs of the two case studies, Cambodia and Turkey.

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### 2.1 Cambodia Polio Eradication Campaign

Cambodia is a small country in Southeast Asia. It is bordered by Thailand to the west, by the Lao People's Democratic Republic to the north, by the Socialist Republic of Vietnam to the east and by the Gulf of Thailand to the south (see map in Annex A). In 1996, its population was estimated to be 10.7 million inhabitants, with approximately 1 million people living in the capital city, Phnom Penh. Also in 1996, its infant mortality rate was reported to be 115 per 1,000 live births and its under-five mortality rate was 165 per 1,000 live births. The maternal mortality ratio was 650 per 100,000 live births and the total fertility rate 3.7. The coverage rates in the country were 64 percent for OPV3 and DPT3.

Cambodia carried out its first NIDs in February and March of 1995. NIDs were conducted again in 1997. During these NIDs, campaigns were conducted primarily at fixed sites located throughout

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<sup>1</sup> Because it is difficult to distinguish polio-specific AFP cases from other AFP cases, all cases should be reported and investigated and have stool samples tested for poliovirus at accredited laboratories.

<sup>2</sup> The international standard is one case per 100,000 population under the age of 15. These cases occur even if there is no more polio as other diseases can also present with AFP.

the country. The percentage of children under five that were immunized during the 1997 NIDs is shown in Table 1.

**Table 1. Coverage during Polio Eradication Activities, 1997-1998**

<b>Polio Eradication Activity</b>	<b>1<sup>st</sup> Round</b>	<b>2<sup>nd</sup> Round</b>	<b>Zero-dose Children</b>
1997 February/March NID	88.6%	90.3%	
1997 May/June HRRI	97.7%	100%	22%
1997 November/December NID	94.3%	96.5%	
1998 February/March HRRI	96.9	97.7%	1%

Source: Ministry of Health, Cambodia, 1997 and 1998), U.S. Centers for Disease Control and Prevention, 1999.

Note: Zero-dose refers to the proportion of children for whom no vaccination dose was recorded previously.

That same year, the Cambodian Ministry of Health (MOH) changed its approach to immunization, after surveillance data identified that remaining cases of wild polio virus were found among the country's waterways. In May/June 1997, the country began conducting an intensive targeted house-to-house and boat-to-boat approach, called high-risk response immunization (HRRI), in areas that were identified as high-risk (60 percent of the country). The following selection criteria were used to identify the high-risk areas for HRRI: 1) districts with clinically confirmed cases of polio in 1996 and 1997; 2) districts where wild poliovirus was found in 1996 and 1997; 3) all districts of newly liberated areas, and 4) districts in which AFP surveillance was considered weak. Each round of HRRI took place over a time period of 12 days, rather than one day as in the case of NIDs, and had intensified supervision. The percent of children under five that was immunized during the May/June 1997 HRRI rounds was higher than that of the 1997 NIDs and was reported as 97.7 percent and 100 percent<sup>3</sup>, respectively.

Two additional rounds of campaign activities took place in November/December 1997 and February/March 1998, in response to a request by the WHO<sup>4</sup>. The November/December NID/HRRI differed from the earlier NIDs in that it combined approaches that had been used in both NIDs and HRRI. As in the NIDs in low-risk areas, children under five were vaccinated on a single day at fixed posts; however, in high-risk areas, mobile teams were used to vaccinate populations along the waterways. The February/March 1998 HRRI also was conducted in high-risk areas with intensive supervision and extensive use of mobile teams. The coverage during these two rounds were 96.9 percent and 97.7 percent respectively.

Cambodia's surveillance of AFP has steadily improved since its introduction in 1992. Since 1996, Cambodia has sent stool specimens to the Regional Poliovirus Reference Laboratory in Japan, which operates under WHO quality standards. During the period 1994-1997, the proportion of AFP cases with two adequate stool samples also increased from 7 percent to 71 percent. Cambodia's AFP reporting was reported to be 3.2 per 100,000 children under 15 in 1997 and 2.8 in 1998. In 1996 its non-polio AFP rate was 0.87 per 100,000 children under 15 and reached 1.77 in 1997.

<sup>3</sup> The coverage may be high due to inaccurate estimates of target populations.

<sup>4</sup> WHO, Japan, and Australia financed most of this activity.

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## 2.2 Turkey Polio Eradication Campaign

Turkey is located in southwestern Asia (see map in Annex A). Its population was estimated to be 63.4 million in 1998 (State Institute of Statistics 1998) and its population growth rate is 1.5 percent. In 1998, the country's infant mortality rate was 42.7 per 1,000 live births (DHS 1998) and the total fertility rate was 2.6. While the coverage for OPV3 was approximately 70 percent for the country, there was considerable variation by region. For example, in the Eastern Region, only 47 percent of children aged 12-23 months had received OPV3 (DHS 1998).

Since 1995, Turkey has conducted two rounds of NIDs each year in April and May, simultaneous with bordering countries (Iran, Iraq, and Syria) as part of the Operation MECACAR (Mediterranean, Caucasus, Central Asian Republics). After determining that many women particularly women living in rural settlements known as *mesras*, were not coming out of their homes for immunization of their children, the Turkish MOH decided to use door-to-door immunizations in most rural areas. In 1998, 60 percent of children under five were vaccinated at home using the door-to-door strategy. The NIDs differed from mop-up activities in that they were characterized by little central-level involvement during this campaign; most planning and supervision was done at the provincial level.

The April/May 1999 NIDs differed from the 1998 ones in the sense that the MOH provided more strategic planning and supervision took place and more resources. For example, the funding for advertising doubled in Sanliurfa. In addition, the number of personnel receiving training increased by 50 percent and 150 percent in Sanliurfa and Mardin, respectively. A second difference was a heavier reliance on the door-to-door strategy during the 1999 NIDs. In each round, 84 percent of vaccinations were delivered via mobile immunization teams that conducted household visits (Table 2). The central government also increased its support for social mobilization, including the use of mass media.

**Table 2. Coverage during Polio Eradication Activities, 1998-1999**

Polio Eradication Activity	% of Target Population Covered
1998 NID	93%
1998 Mop-up	65%
1999 NID	92%
1999 Mop-up	85%

Source: MOH Turkey 1999.

Mop-up campaigns began in 1997, targeting high-risk and low-coverage areas primarily in the southeast and eastern parts of the country. Provinces were selected for inclusion in mop-ups based on the following criteria: less than 80 percent routine immunization coverage; poor AFP surveillance, and detection of wild polio virus or high risk of poliovirus transmission from neighboring countries.

The October/November 1998 mop-up campaign targeted 11 provinces in the southeast and eastern parts of the country. During this mop-up campaign, extensive training was done. Due to enhanced planning and central-level involvement, the overall quality of the mop-up immunization activities improved.

Mop-up campaigns continued in 1999, mainly because of the confirmed transmission of wild poliovirus in Iraq. The campaign in October and November targeted 22 high-risk provinces primarily in the southeast and eastern parts of the country. The provinces, home to 29 percent of the total target

population or roughly 1.9 million children, were selected according to the following criteria: provinces with polio cases in 1997 and 1998; provinces bordering areas with polio cases; and provinces with low routine OPV3 coverage. This campaign had a large involvement at the central level and additional resources were provided for operational costs. Coverage rates during the first and second rounds were 83 and 87 percent respectively.

AFP surveillance has improved in Turkey since it began in 1989. In 1997, the WHO viral classification scheme for AFP cases was introduced, and only AFP cases with wild poliovirus isolations were confirmed as polio. The national non-AFP rate was close to the targeted 1 per 100,000 in 1998 and the country exceeded the rate in 1999. However, some variation continues to take place across certain areas in the Marmara, Black Sea, and Aegean regions. AFP surveillance is strong in the areas of highest risk in the southeastern and eastern parts of the country.

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### 3. Literature Review

Before describing the methodology of the study, it is useful to review the literature on cost studies on polio eradication campaigns. Several studies have been conducted on the cost, cost-benefit, and cost-effectiveness of immunizations. These studies have ranged from those that have investigated the cost-benefit or cost-effectiveness of specific immunizations in order to justify their inclusion in immunization programs (Ponniguhau 1980, Shepard et al. 1986, Asensi et al. 1995) to studies conducted by the Resources for Child Health Project (REACH) that compared different service delivery strategies (Brenzel 1990). The latter studies found that routine delivery of services was less costly per fully immunized child (FIC) than mobile teams or campaigns.

While several cost studies of immunization programs have been conducted, relatively few have investigated polio eradication campaigns. Bart et al. (1996) assessed the cost-benefit of polio eradication campaigns and estimated that benefits will accrue once polio eradication is complete. Another study evaluating house-to-house versus fixed-site oral polio vaccine delivery strategies in a mass immunization campaign in Egypt suggested that house-to-house delivery may be the most cost-effective strategy to achieve universal coverage (Linkins et al. 1995).

No study, however, has compared the cost-effectiveness of different mixes of NIDs and house-to-house campaigns that are often used in polio eradication campaigns. This study will attempt to fill that information gap.



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## 4. Methodology

Because the campaign for polio eradication is to be accelerated in the year 2000 and resources for these campaigns are limited, a comparison of costs of different approaches should be undertaken to determine less resource-intensive ways in which to carry out the work.

The majority of the costs associated with polio eradication activities are those for provision and evaluation of supplemental immunization activities. These include expenditures made by ministries of health, WHO, UNICEF, donors, communities, and others for national immunization days, mop-up activities, and surveillance. To determine the costs of polio eradication approaches, three types of analysis can be conducted: cost analysis, cost-benefit analysis, and cost-effectiveness analysis.

**Cost Analysis.** Cost analysis is a tool used to value the resources used in service provision such as provision of polio supplemental immunizations (total costs) or as the unit costs of delivering them (average cost). Total costs are useful to planners for budgeting purposes. Average costs allow comparisons to be made among approaches. Yet a third measure is marginal costs, the additional cost associated with delivering one more immunization. This measure takes into account varying costs at different levels of output.

**Cost-effectiveness Analysis.** A second type of tool of analysis and the one that will be used in this study is to compare the costs of different operational approaches of polio immunization with their effectiveness. The advantage to using this tool is that it allows the costs of an approach to be compared with its outcome. Using this type of analysis, an approach will then be considered more cost-effective than another if its cost per output or outcome is less than that of another approach. So, for example, if two approaches to polio eradication are found to be equally effective, but one costs less than the other, program managers would be more likely to choose the one that is less costly. On the other hand, an approach that costs more than another one may still be cost-effective if its effectiveness is significantly higher. Measures of effectiveness for polio eradication campaigns range from process indicators such as a service provided or coverage levels to outcome indicators such as cases of polio averted.

As part of the analysis, the costs and measures of effectiveness of alternatives are compared through cost-effectiveness ratios. This ratio is calculated by dividing the cost of an alternative, expressed in monetary terms, by the effectiveness of that alternative, expressed in nonmonetary terms. For example, the cost per immunization or polio case averted could be estimated.

Marginal cost-effectiveness refers to the additional cost-effectiveness associated with one additional unit of outcome.

**Cost-benefit Analysis.** A third type of analysis, cost-benefit analysis, relates the costs of providing a service to the monetary benefit that it provides. In this type of analysis, the costs of activities such as an polio eradication campaign in either a country or worldwide are compared to the cost savings that will occur after eradication has taken place and polio immunization is no longer necessary. The difficulty with this type of analysis is putting a monetary value on the benefit from an activity. For example, for polio eradication, assumptions about the size of the benefits of eradication need to be made. These include the amount of cost savings associated with the cessation of polio immunization and treatment of polio cases. Such an approach has been taken in studies such as Bart

et al. (1996) that estimate the break-even point at which benefits exceed cost for polio eradication. Because many of the costs and benefits do not occur in the present year in this analysis, they need to be discounted to present value to take account of the lower value placed on benefits received in the future than at present.

The type of analysis that has been applied in this study is cost-effectiveness analysis. This type of analysis is the most appropriate since it allows comparisons to be made between different approaches for polio eradication and does not require monetary values to be placed on outcomes.

A cost-effectiveness analysis of an eradication campaign differs from other analyses of health services because, by its very nature, full efforts must be made to immunize every child or the benefits of the campaign will not be realized (Melgaard et al. 1998). The costs of reaching hard-to-reach groups, such as children of transient populations or those living in high-security areas, will be higher than those of the general population. Additional costs to fully immunize target populations are necessary in the short-term in eradication campaigns in order that long-term benefits of stopping immunization with the particular antigen can take place. However, choices between different approaches to reach the goal of polio eradication with different cost-effectiveness can still be made, and that is what this study is trying to examine, applying cost-effectiveness analysis to two case studies, Cambodia and Turkey.

In the two case studies, mass immunization campaign approaches were tried that combined both fixed-site immunization with targeted house-to-house immunization. The cost-effectiveness of these approaches are compared with non-targeted approaches with lower investment in surveillance as well as varying levels of investment in training, supervision and social mobilization.

Some specific questions that are examined in this study include the following:

- > How does the marginal cost-effectiveness of immunizing hard-to-reach populations compare to the cost-effectiveness of reaching the general population?
- > Are targeted house-to-house immunizations with reasonable surveillance (non-polio AFP rate > 1) more cost-effective than non-targeted house-to-house immunization with inadequate or no surveillance?
- > Is an activity that combines two approaches more cost-effective than conducting the two approaches separately?
- > Are house-to-house campaigns more cost-effective when an intensified management approach is taken, i.e., additional resources are introduced for supervision, social mobilization, and training, than house-to-house campaigns with less intensified management?

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## 5. Case Studies

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### 5.1 Cambodia

In order to answer the first three research questions, the Cambodia case study evaluated and compared the costs and effectiveness of operational approaches involving different combinations of national immunization days and high-risk response immunizations and also different levels of surveillance. First, to assess the additional costs associated with immunizing hard-to-reach populations, the costs of the February/March NIDs and combined NID/HRRI of November/December 1997 are compared, since the latter activity involved the use of additional resources such as mobile boat teams in order to reach children living along the country's waterways.

For the second and third questions, a comparison of cost-effectiveness is made between two sets of alternatives (Table 3). To assess the cost-effectiveness of having a good surveillance system, the cost-effectiveness of conducting the February/March HRRI (covering 60 percent of the population) with good surveillance is compared with the simulated costs of conducting a nationwide HRRI with poor surveillance. The latter approach would likely have taken place if the surveillance of non-polio AFP had been poor since the source of the last few remaining cases of polio in Cambodia could not have been identified.

**Table 3. Alternative Approaches in Cambodia**

	<b>Alternative 1</b>	<b>Alternative 2</b>
Investment in Surveillance	Targeted HRRI with high investment in surveillance Coverage = 97%	Simulated nationwide HRRI with limited investment in surveillance Assumed coverage = 96%
Combining Approaches	Separate NID and HRRI Campaigns NID Coverage = 89% HRRI Coverage = 99%	Combined NID/HRRI campaign Coverage = 95%

The cost-effectiveness of combining campaign approaches, as in the November/December 1997 NID/HRRI, is compared with the cost-effectiveness of two separate campaign activities, as in the February/March 1997 NID and May/June 1997 HRRI.

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### 5.2 Turkey

In the Turkey case study, the cost-effectiveness of different approaches to house-to-house campaigns is evaluated in the region of the country with recent cases of polio, the Southeastern Region. This analysis addresses the fourth research question: Were house-to-house campaigns more

cost-effective with more intensified management, e.g., additional resources provided for supervision, social mobilization, and training?

Two sets of comparisons are made between house-to-house campaign approaches (Table 4). First, the cost-effectiveness of NID activities in 1998 is compared with the mop-up activities of 1999. The reason for this comparison is that the NID activities were conducted through house-to-house immunization in rural areas due to the difficulty of persuading children's mothers or other caretakers out of their houses and therefore were similar to mop-up activities. On the other hand, the NIDs involved less microplanning, supervision, and training than the mop-ups. The comparison is thus between two approaches to house-to-house immunization: the former with less supervision, training, and funding for operational costs (per diems and transport), and the other one with more supervision, supplies, and training. The assumption that is made in this analysis is that the effectiveness of coverage during the 1998 NIDs is lower than that of mop-ups due to limited supervision and training (assumption that effectiveness of coverage was 75 percent as compared to 85 percent).

**Table 4. Alternative Approaches to Polio Eradication in Turkey**

	<b>Alternative 1</b>	<b>Alternative 2</b>
Investment in training, supervision and social mobilization for NIDs and mop-ups	NID in 22 provinces (mop-up provinces) with limited investment in management support	Mop-ups in 22 provinces with more intensive investment in management support
Investment in training, supervision and social mobilization for NIDs	Countrywide NID with limited investment in management support	Countrywide NID with more intensive investment in management support

The second comparison is between the NID activities in 1998 and 1999 since the MOH changed their approach towards NIDs in 1999. The main difference between these two activities is that the 1999 NIDs had more supervision and training. The assumption is made that effectiveness of coverage is higher in the 1999 NIDs (80 percent) than in the 1998 NIDs (75 percent).

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## 6. Cost Data

In determining the costs of a polio eradication activity, the unit costs of all inputs involved in the polio eradication activities are collected. Even the costs of resources that are already paid for under routine budgets are included since alternative uses of these resources are possible. For example, the costs of health workers' time should be calculated because they would otherwise be providing other services with this time. Because having a good surveillance system is so important to measuring the effectiveness of the polio eradication activities, it is also necessary to collect information on the costs of this component.

The cost categories are disaggregated into recurrent and capital costs because these costs are calculated differently. Recurrent costs are the value of items that are used within a period of one year or less, while capital costs are costs of items that have a life expectancy of one year or more. Because capital costs have a life expectancy of over one year, the costs are spread over its expected life. Thus, the costs that are attributed to a specific polio eradication activity would only be a portion of the total, and would need to be annualized.

The data on costs includes the following components: personnel, vaccines, supplies, transport, training, social mobilization, cold chain, and technical assistance<sup>5</sup>, as can be seen in Table 5. It should be noted that, while an effort was made to estimate costs of activities through estimating the actual number of resources used, in some cases only information on amounts budgeted, or expenditures, for the activity was available, e.g., social mobilization expenditures. In a few cases, information was available in one country but not the other.

In Cambodia, data on costs were collected through the WHO Western Pacific Regional Office in Manila and communications with the Cambodia WHO representative for polio eradication activities. Information was provided on the quantity of resources used for the campaign such as vaccines, social mobilization, and cold chain.

Some specific assumptions that were made in estimating costs of polio eradication campaigns in Cambodia were the following: 1) In order to estimate the cost of health worker time, it was assumed that one health worker at each health post spent a total of 10 days in preparation and in providing immunizations during each two rounds of NIDs or HRRIs; 2) Vaccine costs were estimated through calculating the number of vials required to immunize the target population in each province, assuming vials of 20 doses and 20 percent wastage (personal communication, WHO Cambodia, 1999); and 3) In simulating the cost of a nationwide HRRI, the percent of additional costs to total costs associated with providing services in high-risk areas in the 1997 November/December NIDs over the 1997 February/March NIDs (when no areas were designated as high-risk) was calculated for the following cost categories: personnel, transport, and social mobilization. The estimated costs of providing intensive HRRI-like activities in the low-risk areas were calculated through adding the same percentage of additional costs in low-risk districts as high-risk districts in the same province<sup>6</sup>; 4) The costs of international consultants were also assumed to increase from three to five in a nationwide HRRI; and 5) Costs of surveillance activities were assumed to be approximately \$100,000 a year

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<sup>5</sup> Data on the costs of technical assistance in Cambodia for each activity were included since they were provided with each activity and were not considered a one-time or periodic assistance.

<sup>6</sup> In the four provinces with no high-risk areas, the additional costs of the three categories were doubled. No costs were added in the provinces which were designated as all high-risk.

(personal communication, WHO Cambodia), and half of the annual surveillance costs were allocated to each HRRI. A summary of key assumptions is shown in Table 6.

**Table 5. Availability of Cost Data in Cambodia and Turkey**

Cost Category	Components	Information available in:	
		Cambodia	Turkey
Personnel	Health worker salaries	X	X
	Per diems: supervisors and volunteers	X	X
	Meals		X
Vaccines	Estimated number of vials of OPV opened	X	X
	Price per vial	X	X
Supplies	Forms, checklists	X	X
	Calendars	X	
Transport	Boat hire, moto hire, car rental*	X	X
	Vaccine transport*	X	
	Supervisor transport*	X	
	Provincial transport*	X	
	Fuel cost*		X
	Driver's cost*		X
	Maintenance*		X
Training	Training of district supervisors	X	
	Training of personnel		X
	Planning meeting	X	X
	Salaries		X
	Per diems		X
Social Mobilization	Meetings		X
	Per diems		X
	Posters, leaflets, banners, loudspeakers	X	X
	T-shirts, pens	X	X
	TV spots, radio spots	X	X
Cold Chain	Ice*	X	
	Cold boxes	X	
	Maintenance*	X	X
	Vaccine carrier		X
Technical Assistance	Salary of international consultants	X	
	Per diem of international consultants	X	

\*Expenditure data was used to estimate these cost components.

In Turkey, data were collected at the central level through the Polio Unit as well as Administrative and Finance Unit of the Primary Health Care Department in the Ministry of Health. Data were also collected at two provinces in the Southeastern Region where mop-up activities were conducted in 1997-99, Sanliurfa and Mardin Provinces. Assumptions made in the estimation of costs include: 1) The cost of vaccines were calculated through multiplying the number of opened vials by its unit cost; and 2) To calculate the costs/expenditures in all mop-up provinces based on information from two provinces, an average cost per administered dose by provinces and by national level was estimated and multiplied by the target population multiplied by the coverage in all mop-up provinces or nationally.

**Table 6. Assumptions used in Calculation of Cost and Effectiveness**

<b>Cost</b>	<b>Effectiveness</b>
1. Ten days spent by each health worker in preparation and immunization provision in Cambodia	1. Effectiveness of coverage was 75-85%, and higher for activities that were smaller or had more supervision and training
2. Twenty percentage vaccine wastage assumed in Cambodia; vaccine use in Turkey calculated by multiplying no. of open vials by unit cost	2. 50% of children not fully covered by routine immunization already had received three doses of polio through NIDs or mop-ups
3. Average cost of service provision at provincial level estimated and applied to total number of provinces to estimate provincial contribution in Turkey	3. Seven children out of 1000 would contract paralytic polio if not previously vaccinated



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## 7. Effectiveness Data

The measures of effectiveness include number of OPV doses administered in a NID or HRRI, percent coverage of target population, number of children that changed their status from susceptible to non-susceptible<sup>7</sup> to polio, and number of cases of polio-specific paralysis averted during a polio eradication activity.

To calculate the number of cases of paralytic polio averted during a polio eradication activity, the reported coverage was multiplied by the number of children in the target population, multiplied by the percentage of children not covered through routine immunization (one minus the OPV3 coverage from routine immunization). This number was multiplied by the pre-EPI (Expanded Program on Immunization) polio prevalence rate of paralytic poliomyelitis. The assumptions included: 1) Effectiveness of coverage, the percent of those vaccinated with OPV who developed detectable levels of neutralizing antibodies, was assumed to be 75-85 percent of all children vaccinated during campaigns due to breakdowns in the cold chain and malnutrition, with higher percentages for activities that were smaller and/or had more supervision<sup>8</sup>; 2) Children under five had received one or more doses of OPV through a previous polio eradication activity or routine EPI, with 50 percent of children under five not fully covered through routine immunization having received the full three doses of polio from previous campaigns<sup>9</sup>; and 3) Seven children out of 1,000 children (Nicholas et al. 1977) would contract paralytic polio if they were not vaccinated.

The number of children that went from two dose or less status to non-susceptible status was defined as the number of children that received their second or more dose of OPV during the polio eradication activity. This number was calculated through first estimating the number of two dose or less children (one minus the OPV3 level from routine immunization coverage rate multiplied by target population number and effectiveness of coverage). The number of these children that had not been covered by a previous NID or mop-up was then assumed to be 50 percent of these children. The susceptible children who became non-susceptible were those covered under the NID or mop-up, multiplied by the effectiveness of coverage of the activity.

Adjustments were made to the Turkey coverage data for NIDs in 1998 since the reported coverage rates for these activities were likely to have been inflated due to limited supervision. Based on comparison with coverage rates of the 1999 mop-up campaigns, which emphasized microplanning, supervision, and training and reported coverage of 85 percent in 22 provinces (75 percent and 76 percent in Sanliurfa and Mardin Provinces, respectively), the assumption was made that coverage rates were inflated by 10 percent for the 1998 NIDs as a whole.

Because the results may be sensitive to some of the assumptions about effectiveness, some sensitivity analysis was performed, i.e., the analysis was performed using varying rates. For example, the effectiveness of coverage was varied in the analysis.

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<sup>7</sup> It should be noted that some children are not completely non-susceptible after four polio immunizations and instead are only partially non-susceptible.

<sup>8</sup> This assumption followed those used by Bart et al. (1996).

<sup>9</sup> This assumption is based on information on the percent of zero-dose children in a 1999 WHO memo (WHO 1999).

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## 7.1 Measures of Cost-Effectiveness

Three measures of cost-effectiveness are used in this study: cost per administered dose, cost per case of polio-related acute flaccid paralysis averted, and cost per conversion to non-susceptible. The cost per administered dose is a process variable rather than an outcome measures and is obtained through dividing the cost of the polio eradication activity by the total number of administered dose.

The other two measures are outcome measures of cost-effectiveness. The cost per case of paralysis averted relates the cost of an activity to its health benefit which is to prevent cases of polio-related paralysis.

The second outcome measure was also added to reflect the unique nature of polio eradication activities. Since the goal of the activity is to lower transmission of the polio virus, the conversion of susceptible children to non-susceptible ones is an outcome of the activity. For that reason, the cost of the conversion to non-susceptible was also calculated as a measure of cost-effectiveness.

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## 8. Results

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### 8.1 Cambodia Cost-effectiveness Analysis

The first step of the analysis was to compare the costs of immunizing the general population with a more comprehensive campaign that includes hard-to-reach populations that were identified through surveillance activities. To do so, the costs of NIDs in February/March 1997 were compared with the costs of NIDS November/December 1997 that had added intensive activities such as immunization with mobile boat teams. The increase in coverage from the February/March NID to the November/December NID was about 6 percent (from 89 percent to 95 percent) (Table 7).

Total costs of the more intensive November/December NID/HRRI were higher than the earlier NIDs by approximately \$113,000. As expected, the cost per dose administered increased slightly during the latter NID from \$0.32 to \$0.35, due to additional costs spent on boat teams, personnel, and social mobilization. However, the costs per case of paralysis averted and cost per non-susceptible were similar, due to the higher reported effectiveness of the latter NID/HRRI.

**Table 7. Cost-effectiveness Measures of February/March 1997 and November/December 1997 NIDs**

Cost Category	Cost of February/March NID w/ fixed posts	%	Cost of November/December NID with fixed posts and mobile teams	%
Personnel	\$ 265,358	23%	\$336,288	27.0%
Vaccines	\$ 423,522	37%	\$405,424	32.6%
Supplies	\$ 2,000	0.1%	\$ 2,000	1.6%
Transport	\$ 73,114	6.5%	\$ 58,562	4.7%
Training	\$ 6,240	0.6%	\$ 5,814	0.5%
Social mobilization	\$ 312,850	27.6%	\$382,598	30.7%
Cold chain	\$ 34,182	3%	\$ 39,646	3.2%
Technical assistance	\$ 15,000	1.3%	\$ 15,000	1.2%
<b>TOTAL</b>	<b>\$1,132,266</b>	100%	<b>\$1,245,272</b>	100.0%
Size of target population	1,961,707	NA	1,888,162	NA
% coverage by round	88.7%, 90.2%	NA	94.3%, 96.5%	NA
Cost per dose administered	\$0.32	NA	\$0.35	NA
Effectiveness of coverage	80%		85%	
Susceptible population	478,656	NA	460,711	NA
No. of cases averted	2,240	NA	2,444	NA
Cost per case averted	\$505	NA	\$510	NA
# of non-susceptible	320,066	NA	349,093	NA
Cost per non-susceptible	\$3.54	NA	\$3.57	NA

Because only two data points are available and these are not sufficient to determine marginal cost with each additional percentage of coverage, the additional cost has been calculated for increasing the coverage through NIDs and HRRIs to achieve polio eradication assuming that the cost per each additional percentage is the same. With that assumption, the cost per additional percentage is \$18,993.

Even though additional costs were required to immunize the hard-to-reach populations along the waterways, the cost would have been even higher if the surveillance system of non-polio AFP had not been in place and of adequate quality (non-polio AFP rate >1.0). With information from the surveillance system, the MOH was able to conduct targeted HRRIs, i.e., identify high-risk areas for polio transmission. Without this information, the MOH and WHO program managers that were trying to reach all unimmunized children to successfully eradicate polio would have found it necessary to have a much larger house-to-house campaign such as a nationwide campaign.

Table 8 presents the costs of the February/March 1998 HRRI and compares it to the simulated costs of conducting a countrywide HRRI in Cambodia. The assumption is made that in the countrywide HRRI scenario with poor surveillance, expenditures on surveillance activities were half of those when surveillance was adequate (non-polio AFP rate >1.0). The effectiveness of coverage was assumed to be 80 percent in the nationwide HRRI, as compared with 85 percent for the smaller HRRI.

A countrywide HRRI was estimated to cost \$607,334 (Column 2 in Table 8), more than the targeted HRRI did in February/ March 1998. It also cost \$0.03 more per dose administered and about \$58 more per case averted when effectiveness of coverage was assumed to be 80 percent. When this assumption was varied and changed to 85 percent (see last column in Table 8), the difference in cost per case averted was smaller (\$21). Similarly the cost per non-susceptible was \$0.40 and \$0.15 more when the effectiveness of coverage was assumed to be 80 percent and 85 percent, respectively.

**Table 8. Estimated Costs of February/March 1998 HRRI and Countrywide HRRI**

Cost category	Column 1 February/ March 1998 targeted HRRI	Column 2 Simulated countrywide HRRI with 80% effectiveness of coverage	Column 3 Simulated countrywide HRRI with 85% effectiveness of coverage
Personnel	\$241,713	\$384,318	\$384,318
Vaccines	\$269,410	\$405,243	\$405,243
Supplies	\$ 2,000	\$ 2,000	\$ 2,000
Transport	\$ 67,391	\$ 92,088	\$ 92,088
Training	\$ 2,240	\$ 5,813	\$ 5,813
Social mobilization	\$2 02,159	\$477,814	\$477,814
Cold Chain	\$ 40,000	\$ 43,289	\$ 43,289
Technical assistance	\$ 22,500	\$ 42,000	\$ 42,000
<b>TOTAL</b>	<b>\$847,413</b>	<b>\$1,452,747</b>	<b>\$1,452,747</b>
Surveillance costs	\$ 50,000*	\$ 0*	\$ 0*
Size of target population	1,192,915	1,888,162	1,888,162
% coverage by round	97.8%, 96.9%	96%, 96%	96%,96%
Cost per dose administered	\$0.37	\$0.40	\$0.40
Effectiveness of coverage	85%	80%	85%
No. of cases averted	1,574	2,314	2,459
Cost per case averted**	\$570	\$628	\$591
# of non-susceptibles	225,802	330,625	354,270
Cost per non-susceptible	\$3.99	\$4.39	\$4.14

\*50% of total surveillance costs were allocated to these activities. \*\*Includes cost of surveillance

The third analysis was to estimate the cost-effectiveness of the February/March NID and the May/June HRRI and compare with the cost-effectiveness of the combined NID/HRRI campaign in November/December to determine whether there were cost savings. Estimated costs were lower for most categories – personnel, transport, social mobilization, cold chain, and technical assistance – in the November/December NID/HRRI (see Table 9), because resources were shared for the combined activity. The cost of the combined NID/HRRI activity was \$600,000 less than those of the two separate campaign activities totaled. In addition, the cost per case averted was \$236 less for the NID/HRRI than the two activities conducted separately. The cost per non-susceptible was \$1.56 less for the combined activities than for the separate activities.

**Table 9. Comparisons of Costs of February/March 1997 NID and May/June HRRI with November/December 1997 NID/HRRI**

Cost category	Cost of February/March 1997 NID and May/June HRRI			Program cost of combined approach November/December 1997 NID/HRRI
	February/ March NID	May/June HRRI	Total	
Personnel	265,358	161,470	426,828	336,288
Vaccines	423,522	254,560	678,082	405,424
Supplies	2,000	2,000	4,000	2,000
Transport	73,114	69,376	142,490	58,862
Training	6,240	5,488	11,728	5,814
Social mobilization	312,850	164,000	476,850	382,598
Cold chain	34,182	40,000	74,182	39,646
Technical assistance	15,000	22,500	37,500	15,000
<b>TOTAL</b>	<b>\$1,132,266</b>	<b>\$ 719,394</b>	<b>\$1,851,660</b>	<b>\$1,245,272</b>
Size of target population	1,961,707			1,888,162
% coverage of target population	94.3%			94.3%
Effectiveness of coverage	80%			80%
No. of cases averted	2,362			2,273
Cost per case averted	\$784			\$548
# of non-susceptible	337,420			324,770
Cost per non-susceptible	\$5.49			\$3.83

## 8.2 Turkey Cost-effectiveness Analysis

The first analysis undertaken with the Turkey data was to compare the 1998 NIDs and 1999 mop-ups in the two southeastern provinces where data were collected. As noted above, this was the region where the most recent cases of polio in 1997 and 1998 occurred. For this reason, the management support was very high for these provinces in 1999.

As can be seen from Table 10, the mop-up activities were costlier than NIDs. As noted above, the approach taken by the MOH to reach the harder-to-reach populations was to introduce mop-up campaigns. In the provinces that had lower coverage or had cases of polio reported, mop-up campaigns were conducted along with NID activities. The additional costs of reaching the target population in these provinces were thus the cost of the mop-up activities. A second way of presenting the additional cost is to compare the cost of the NIDs with the more resource-intensive mop-up campaigns.

In Sanliurfa Province, the cost of the mop-ups conducted in 1999 was higher than the 1998 NIDs by about \$37,000, about 20 percent, because more funds were provided for per diems (20 percent)

and transport (105 percent). In addition, more supplemental funds were provided from the central level. Not surprisingly, the effectiveness of the latter activity was higher (MOH 1999). Because the cost per administered dose was substantially higher for the 1999 mop-ups, the cost per case of polio-related AFP averted was higher by about \$49, or about 7 percent. In addition, the cost per conversion to non-susceptible was about \$0.31 higher in 1999.

**Table 10. Cost of 1998 NIDs and 1999 Mop-up Campaigns in Sanliurfa and Mardin Provinces, Turkey**

Cost Category	Cost of 1998 NIDs in Sanliurfa province		Cost of 1999 mop-ups in Sanliurfa province		Cost of 1998 NIDs in Mardin		Cost of 1999 mop-ups in Mardin	
	Province	Central Level	Province	Central Level	Province	Central Level	Province	Central Level
Personnel	122,985.7		131,653.7	15,939	107,004	4065	95,380	12,555
Vaccines		36,319		31528		16,757		17,144
Supplies	178.9		196.5		0.0		2,184	
Transport	13,008.1	8,130	25,453.0	17,686	8517	6098	12,118	15,939
Social mobilization	792.7		546.0		43		2,601	
Training	5,516.2		1,021.6		6028		17,243	
Cold chain	0.0**		0.0**		122		111	
<b>TOTAL</b>	<b>\$186,931</b>		<b>\$224,024</b>		<b>\$118,206</b>		<b>\$175,377</b>	
Size of target population	240,075		236,305		133,550		130,125	
Adjusted coverage by round	75%		75%		68%		76%	
Cost per dose administered	\$0.53		\$0.56		\$0.65		\$.89	
Effectiveness of coverage	75%		85%		75%		85%	
No. of cases averted	284		317		143		177	
Cost per case averted	\$659		\$708		\$826		\$993	
# of non-susceptible	40,546		45,231		20,450		25,239	
Cost per non-susceptible	\$4.61		\$4.95		\$5.78		\$6.95	

\*\*No expenditures were made for cold chain.

In Mardin Province, the costs of the 1999 mop-ups were greater than the 1998 NIDs due to more funds for transport and training. The cost per paralytic polio case averted was higher for the 1999 mop-up, due to the higher number of resources provided for this campaign.

When the comparison is made for the 22 1999 mop-up provinces as a whole, however, different results are found. Although the estimated cost was still greater for the mop-ups than NIDs, as would be expected (see Table 11), the outcome cost-effectiveness measures were lower for the 1999 mop-ups. This is probably because the expenditures for the polio eradication activities were particularly high in the two provinces surveyed since these were the last provinces to have polio cases.

When per dose provincial expenditures on the campaign were compared, it was similar for the NIDs and mop-ups (\$0.53 and \$0.52). The per dose central government expenditure on the campaign, on the other hand, was 58 percent greater for the mop-ups than for the NIDs, and the total cost per dose was higher for the 1999 mop-ups by \$0.10, or 14 percent. However, despite the higher cost, due to the greater effectiveness of the mop-up campaign, the cost per case averted was found to be lower by \$24, or 3 percent, and by \$0.18 for each non-susceptible status.

**Table 11. Cost Measures of 1998 NIDs and 1999 Mop-ups in 22 Mop-up Provinces**

	Column 1	Column 3
Measure	Cost of 1998 NIDs in mop-up provinces if effectiveness of coverage is 75%	Cost of 1999 mop-ups in 22 mop-up provinces
Cost per administered dose to provincial government	\$0.53	\$0.52
Cost per administered dose at central level	\$0.19	\$0.30
Total cost per dose	\$0.72	\$0.82
Cost of activity to provinces	\$1,554,144	\$1,694,708
Cost of activity at central level	\$ 631,420	\$ 983,989
Total cost	\$2,185,564	\$2,678,697
Target population	1,954,898	1,916,710
Adjusted coverage rate	75%	85%
Effectiveness of coverage	75%	85%
No. of cases averted	2,311	2,911
Cost per case averted	\$946	\$920
# of susceptibles converted to non-susceptibles	330,164	415,793
Cost per non-susceptible	\$6.62	\$6.44

Note: The coverage rate for NIDs in the 22 provinces was assumed to be 75% rather than 83% for the country as a whole since the coverage in Sanliurfa and Mardin Provinces was at this level.

The second step of the analysis was to compare the cost-effectiveness of the NIDs in 1998 and 1999. The comparison was made because the MOH changed its approach towards NIDs in 1999 and provided more centrally funded resources for the NIDs in 1999 than in 1998. As can be seen from Table 12, more funds were available for training in Sanliurfa Province in 1999 than in 1998, and more funds were available for social mobilization and training in Mardin Province than in 1998. Despite additional expenditures for training in Sanliurfa for the NIDs in 1999, the total cost of the rounds decreased due to lower spending on personnel and transport. In Mardin Province, however, total costs were higher for NIDs in 1999 by 12 percent because of more funds spent on vaccines, larger training activities and the use of more promotion materials.

**Table 12. Cost Measures of NIDs in 1998 and 1999 in Sanliurfa and Mardin Provinces in Turkey**

Cost Category	Cost of 1998 NIDs in Sanliurfa Province		Cost of 1999 NIDs Sanliurfa Province		Cost of 1998 NIDs in Mardin		Cost of 1999 NIDs in Mardin Province	
	Province	Central Level	Province	Central Level	Province	Central Level	Province	Central Level
Personnel	122,985.7		116,492		76,577	4,065	77,812.5	7,664
Vaccines		36,318.8		36,392		16,757		20,422
Supplies	178.9		195		0.0		793	327
Transport	13,008.1	8,130	11,719	4591	8517	6,098	10125	4,770
Social mobilization	792.7		328	656	43		3567	378
Training	5,516.2		9,650	2,322	6028		14727	353
Cold chain	0.0		156	0	122		88.5	
<b>TOTAL</b>	<b>\$186,930</b>		<b>\$182,501</b>		<b>\$118,206</b>		<b>\$141,027</b>	
Size of target population	240,075		236,305		133,550		130,125	
Adjusted coverage	75%		81%		68%		76%	
Cost per dose administered	\$0.52		\$0.48		\$0.65		\$0.71	
Effectiveness of coverage	75%		80%		75%		80%	
No. of cases averted	284		322		143		166	
Cost per case averted	\$659		\$567		\$826		\$848	
# of non-susceptible	40,546		45,976		20,450		23,755	
Cost per non-susceptible	\$4.61		\$3.97		\$5.78		\$5.94	

The results indicate that the 1999 NIDs were more cost-effective than the 1998 NIDs in Sanliurfa Province (Table 13). The cost per case averted was lower by \$92, or 14 percent, while the cost per non-susceptible was lower by \$0.64.

In the case of Mardin Province, the cost per case averted was slightly higher by \$26, or 3 percent, due to the higher costs in 1999 as well as a smaller target population. If the cost per case averted or conversion to non-susceptible is calculated, keeping the population size constant between the two years, the cost per case averted was about the same.

The second part of the analysis involves comparing the cost-effectiveness of the 1998 and 1999 NIDs<sup>10</sup> as a whole. The cost per administered dose of OPV was about the same for both sets of NIDs, and the cost was slightly lower in 1999 due to the smaller size of the target population (Table 13). These results suggest that although more resources were available for NIDs to strengthen planning, social mobilization, and training in 1999, resources were reallocated rather than increased for the latter campaign.

<sup>10</sup> The total costs are higher than in the previous tables because the activities are countrywide rather than in selected provinces.

**Table 13. Cost-Effectiveness of 1998 NIDs and 1999 NIDs**

<b>Measure</b>	<b>Cost of 1998 NIDs assuming 75% effectiveness of coverage</b>	<b>Cost of 1998 NIDs assuming 80% effectiveness of coverage</b>	<b>Cost of 1999 NIDs</b>
Cost per administered dose to provincial government	\$0.53	\$0.53	\$0.52
Cost per administered dose at central level	\$0.19	\$0.19	\$0.18
Total cost per dose	\$0.72	\$0.72	\$0.70
Cost of activity to provinces	\$6,000,537	\$6,000,537	\$6,386,478
Cost of activity at central level	\$2,189,894	\$2,189,894	\$2,245,198
Total cost	\$8,190,431	\$8,190,431	\$8,631,676
Target population	6,779,985	6,779,985	6,647,540
Coverage rate	80%	80%	92%
Effectiveness of coverage	75%	80%	80%
No. of cases averted	5,766	6151	6,935
Cost per case averted	\$1,420	\$1,332	\$1,245
# of non-susceptible	823,768	878,686	990,749
Cost per Non-susceptible	\$9.94	\$9.32	\$8.71

The 1999 NIDs were found to be more cost-effective than the 1998 NIDs. When the cost per case of paralytic polio averted was calculated and compared for the two NIDs, the cost was found to be lower for the 1999 NIDs by approximately 12 percent if effectiveness of coverage in the 1998 NIDS was assumed to be 75 percent and 7 percent if effectiveness of coverage is assumed to be 80 percent. The cost per non-susceptible was \$1.23 and \$0.61 lower, respectively.

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## 9. Discussion

This study examined the cost-effectiveness of variations of fixed site and house-to-house service delivery approaches to reach polio eradication. In the Cambodia case study, the cost-effectiveness of having targeted polio eradication activities with adequate surveillance was compared to conducting non-targeted activities with less substantial investments in surveillance. A second comparison was made to determine whether conducting two separate activities, NIDs and HRRIs, was more or less cost-effective than conducting a combined activity. An additional calculation was carried out to determine the marginal cost-effectiveness of reaching the transient boat populations along the waterways through the use of mobile teams.

The results indicated that conducting NIDs and HRRIs were more cost-effective when an adequate surveillance system was in place and cost savings were realized, because a non-targeted approach would have cost more than the targeted approach. Having reasonable surveillance allows countries to target when they conduct house-to-house activities. These results suggest that countries should make strong efforts to improve their AFP surveillance since they will then be able to realize cost savings without lowering the effectiveness of their activities.

A second approach that was tried in Cambodia in November/December 1997 was to combine the two approaches of NIDs and house-to-house immunization into one activity. Using this approach allowed cost savings to be realized for the combined activity since resources could be shared for the two activities. The cost per dose administered was about \$1.00 for the two separate activities and only about \$0.70 for the combined activities. In addition, the cost per case of paralytic polio was about 30 percent higher when the two activities were conducted separately. The combined approach is an approach that countries may want to consider when they have limited resources for campaigns but are still trying to reach the harder-to-reach groups. However, one disadvantage of taking this approach could be that additional planning and training would make this approach more complicated.

In Turkey, the results indicated that well-managed house-to-house immunization activities, while being costlier, were on average more cost-effective than those with limited management support as in the case of the NIDs in 1998. The mop-ups were found to be more cost-effective because they were able to increase the coverage of children with their intensified approach. Another benefit was the higher health worker motivation in the provinces for conducting these activities. This finding suggests that greater investment in management support of activities provides sufficient benefits even though the costs of the activity will increase.

A similar finding between different NIDS programs was found, because the 1999 NID, which had greater management support, was found to be more cost-effective than the 1998 NID. This result suggests that even without high central-level involvement as in the case of the mop-up campaigns, additional funding for management support increased the cost-effectiveness of the campaign.

The findings of the study should be understood within the context of the limitations of the studies, however. That is, the data on costs and effectiveness were not always complete, requiring substitution of expenditures for costs at times as well as the use of assumptions.

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## 9.1 Policy Implications

The two case studies indicate that it is possible to realize cost savings and improve cost-effectiveness of a polio eradication campaign without lowering effectiveness. Despite the fact that reaching hard-to-reach populations often involves increasing marginal costs since they must be reached through expensive mobile campaigns such as the one conducted in Cambodia, ways in which cost savings can be realized include targeted mop-up campaigns with appropriate investments in AFP surveillance and combining activities rather than conducting them separately.

In addition, when high-risk areas have been identified through surveillance, implementing a more costly intensive campaign in these areas may realize cost savings in the long-run since fewer additional campaigns will be required.

The findings of the Cambodia case study suggest that:

- > Investment in AFP surveillance should take place to ensure adequate surveillance since targeted mop-up campaigns can be conducted effectively with this information, leading to cost savings;
- > Combining activities such as NIDs and house-to-house campaigns should be considered by countries that require house-to-house campaigns and want to lower costs, if they have sufficient management capacity to do so;
- > The case study in Turkey suggested that, although a well-supervised house-to-house campaign with increased training and social mobilization costs more, the benefits are sufficient to justify the additional costs.

The findings of the Turkey case study suggest that:

- > To ensure that more of the target population are reached in areas with low coverage, additional management support resources from the central level of MOHs are required.
- > Central-level involvement, including not only provision of resources but supervision, is needed to increase the motivation of health workers in campaigns.

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# Annex A. Maps

Map of Cambodia



Map of Turkey





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## Annex B. Bibliography

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